AGRICULTURAL SYSTEMS

Panel Manager - Dr. Gary K. Felton, University of Maryland
Program Director - Dr. Deborah L. Sheely

Although agricultural research has most often focused on individual system elements, the Agricultural Systems program provides opportunities for integration of these elements through a whole systems research approach. The objective is to obtain knowledge that is essential to sustain the viability of the agricultural enterprise. Such research is needed to address directly interactions among the elements that comprise agricultural systems. It is expected that projects will include the active participation of the users of agricultural research, both in project design, implementation, and the adoption of newly developed practices and policies.

This program supports systems research that has the potential to aid in the development and/or evaluation of national, regional, community, and/or farm level practices and policies that will sustain: a safe and adequate supply of agricultural products and services; environmental quality and the natural resource base; human health; the economic viability and quality of life of rural communities; and that will improve our management of issues at the urban and rural interface.

2000-03528 Forage Systems to Reduce Long-term Impacts of Tall Fescue Toxicosis on Cattle

Coffey, K.P.; Coblentz, W.K.; Popp, M.P.; Hellwig, D.; Pohlman, F.; Rosenkrans, C.F.
University of Arkansas; Department of Animal Science; Fayetteville, AR 72701
Strengthening Award; Grant 2001-35209-10079; $184,399; 3 Years

Tall fescue, the predominant forage throughout much of the southeastern and lower midwestern U.S., is largely infected with an endophytic fungus. This fungus improves fescue persistence under adverse conditions but is suspected to cause fescue toxicosis, a problem costing U.S. livestock producers approximately $800 million annually through reduced weight gain, reproductive performance, and immune function. Numerous methods have been tested to reduce fescue toxicosis, but dilution with other non-infected forages has been the most effective in improving animal performance. To improve sustainability of cattle operations in the fescue region, it is necessary to determine forage management practices needed to give less-persistent forages a competitive advantage.

Our goal in this project is to reduce the long-term impacts of fescue toxicosis on cattle by improving longevity of overseeded, less persistent, non-infected forages, and by reducing exposure of calves during times of highest toxicity. These procedures are expected to improve animal production and economic returns and reduce health-related disorders. In one experiment, fall-calving cows will graze infected fescue pastures overseeded with crabgrass and legumes to compare two pasture rotation frequencies and two weaning dates. In a second experiment, spring-calving cows will graze common bermudagrass pastures overseeded with orchardgrass, non-infected fescue, or infected fescue at two rotation frequencies. We will evaluate benefits of these systems by gathering information on (1) forage production, persistence, and species composition, (2) soil fertility changes, (3) cow-calf production, (4) calf weaning stress and health, (5) post-weaning calf production, and (6) economic returns from the different grazing management decisions.

2000-0358 Agro-Ecosystem Indicators of Sustainability as Affected by Cattle Density in Ranch Management Systems

Roka, F.M; Mullahey, J.J.; Bohlen, P.J; Arthington, J.D.; Campbell, K.L.; Coleman, S.W.; Graetz, D.A.; McSorley, R.; Portier, K.; Steinman, A.; Tanner, G.W.; and Williams, M.J.
University of Florida; Institute of Food and Agricultural Sciences; Southwest Florida Research and Education Center; Immokalee, FL 34142-9515

Grant 2001-35211-10080; $530,000; 3 Years

A critical region for addressing sustainable management of cattle grazing systems is south central Florida, where extensive subtropical rangelands intersect with some of the most sensitive and natural systems in the United States. How ranching affects native ecosystems, wildlife habitat, and surface water quality are issues of increasing importance to environmentalists, ranchers, and policy makers. A shared goal among all interested parties is to improve the environmental and economic sustainability of beef cattle ranches.

The objectives of this study are two-fold. The first objective is to quantify the effects of cattle stocking densities on selected ecological indicators, including forage species composition, soil nutrient dynamics, nematode biodiversity, avian community structure, and water quality measures. The second goal is to quantify changes in animal performance resulting from changes in pasture stocking rates and estimate the economic implications. The research will also address the importance of spatial patterns in grazing activity, forage intake and digestion, and dynamic soil processes in relation to the stocking treatments.

This research is an outgrowth of a partnership among the University of Florida Institute of Food and Agricultural Sciences, the Archbold Biological Station, South Florida Water Management District, the USDA-ARS Sub-Tropical Agricultural Research Station, and the Florida Cattlemen's Association. The focal point of the research is the MacArthur Agro-ecology Research Center, a 4,170 hectare ranch supporting a commercial herd of 2,800 brood cows. This project takes an integrated approach to evaluating ranch management systems and will help provide a basis for sustainable ranching operation in the region.

2000-03576 Modeling Corn and Soybean Production in a Sheltered Field

Mize, C.W.; Batchelor, W.D.; Wray, P.H.; Colletti, J.P.; Brandle, J.R.; Takle, E.S.; Hu, Q.; Hallam, J.A.
Iowa State University; Department of Forestry; Ames, IA 50011

Grant 2001-35108-10205; $532,745; 3 Years

Shelterbelts are an important farming practice that can be used to increase crop production, reduce soil erosion, increase biodiversity, sequester carbon, and be aesthetically pleasing. Unfortunately, few farmers understand the benefits they can receive from shelterbelts. We have been developing a computer model called SAMS (Shelterbelt Agroforestry Modeling System) to increase farmers' understanding of shelterbelts. This project will make SAMS a more useful model. The first goal of the project is to create a personal computer version of SAMS that will simulate corn and soybean production across a field with a shelterbelt. The model will estimate the effects, benefits, and costs associated with producing corn and soybeans on a sheltered field. It will be usable across much of the Corn Belt for fields with various types of soil and shelterbelts. Data on shelterbelt structure, microclimate, and crop production from Indiana, Iowa, Minnesota, Nebraska, and Wisconsin will be used to develop and evaluate the model. Microclimatic measurements taken across sheltered fields will be analyzed to determine

how to simulate the influence of a shelterbelt on the microclimate across a sheltered field. Economic analyses of shelterbelt influences will include the impact on crop yield, reduced wind erosion, changes in abundance of wildlife, and carbon storage in the shelterbelt. The second goal of the project is to identify situations in which shelterbelts are economically viable in the Corn Belt. Extension materials will be developed to inform farmers of the results of the analyses and to present detailed information on shelterbelts.

2000-03542 Life Cycle Assessment of a Willow Agriculture and Biomass Energy Conversion System

Heller, M.C.
University of Michigan; Center for Sustainable Systems; School of Natural Resources and Environment; Ann Arbor, MI 48109-1115
Postdoctoral Fellowship; Grant 2001-35314-09998; $90,000; 2 Years

Current energy systems that rely primarily on fossil fuels are not sustainable because of the finite nature of fossil fuels and the environmental impact of their use. Biomass is emerging as an important renewable alternative energy source with potential to reduce greenhouse gas emissions. Agricultural production of biomass energy crops will present alternative uses for marginal soils; opportunities for improved stewardship of air, water, and soil resources; and new stable economic markets for rural America. As part of the joint USDOE and USDA sponsored Biomass Power for Rural Development initiative, a system is being developed in New York to generate electricity from short rotation willow crops. Overall sustainability of this bioenergy system is dependent on its environmental performance, in addition to economic and social aspects. The research proposed here will provide a "cradle to grave" life cycle assessment of the resource utilization and environmental impact of this willow to electricity system.

The life cycle assessment will inventory energy and resource demand as well as pollutant emissions for each process contributing to the generation of electricity from willow biomass: production of agricultural inputs, manufacture of farm implements and transportation equipment, preparation of soil, planting, cultivation and harvesting of the willow crop, transportation to the generating plant, and the final energy conversion at the plant. Results of the life cycle assessment will include: overall energy efficiency of the system, net energy generated per hectare of agricultural production, amount of greenhouse gas emissions avoided, total and process-specific environmental emissions, and cost estimates of generating electricity from willow biomass. These performance indicators will assist policymakers, investors, program evaluators, and the public and private sector in evaluating willow biomass as an alternative energy system. The life cycle assessment will also be valuable in identifying specific areas within the willow to electricity system where effective improvements can be made.

The post-doctoral fellow and faculty mentor will collaborate with researchers at SUNY-ESF (Syracuse) and NREL in several aspects of data collection and life cycle modeling.

2000-03530 System for In-Season Fertilizer Nitrogen Application Based on Predicted Yield

Raun, W.R.; Solie, J.B.; Stone, M.L.; Johnson, G.V.; Klatt, A.R.; Elliott, R.L.; Sayre, K.D.; Reynolds, M.
Oklahoma State University; Department of Plant and Soil Sciences; Stillwater, OK 74078
Grant 2001-35108-10112; $382,000; 3 Years

Worldwide, nitrogen use efficiency (NUE) for cereal production remains at 33%. The unaccounted 67% represents a $15.9 billion annual loss of N fertilizer. Our work will develop a

system for N fertilization that increases wheat grain yields and lowers fertilizer N rates. We have shown that wheat grain yield levels can be predicted using sensor (light) readings taken in January and February from winter wheat. By knowing what the predicted yield level is for every $1m^2$, we can adjust N fertilizer needs based on fall-planting to mid-winter growing conditions. Improved prediction of wheat grain yield levels will be developed and employed in accordance with a new sensor to be tested by our engineers. Parallel work identifying varieties with improved nitrogen use efficiency will take place at 6 locations in the USA and Mexico and that will include 30 common spring and winter wheat varieties. The final result will be a complete technological system that includes a state-of-the-art variable N rate applicator designed specifically for making in-season N applications based on predicted yield level. This system will deliver increased yields at decreased application rates, with the added product of identifying a method for identifying wheat varieties with improved nitrogen use efficiency. Also, this work will be used to determine the economic and agronomic viability of a variable N rate applicator for wheat producers.

2000-01157 Plot-planter for Replicated Field-plot Experiments

DeBroux, S.
Delaware Valley College; Agronomy & Environmental Science Department; Doylestown, PA 18901

Equipment Grant; Grant 2001-35211-10143; $16,750; 1 Year

Using conventional crop planters, we have been limited in the scope and complexity of the field experiments we have been able to perform. A plot-planter will allow us to greatly increase the number of crop varieties that can be entered into our experiments. The plot-planter will allow us to increase our number of replications, thus increasing the precision of our results. In addition, the plot-planter will allow us to use experimental designs that are more powerful than what is currently possible with our conventional planting machinery.

Manure has been identified as an important source of phosphorus load on soils in the Chesapeake Bay watershed. Our previous work has demonstrated that commercially available phytase feed additives in a balanced ration can increase milk production per cow and reduce manure output per cow. It is thought that the phytase additives assist in the digestion and absorption of phosphorus-rich compounds in plant tissues. Plant breeders have long reported that different corn varieties vary in their content of phosphorus compounds. We hypothesize that there is a measurable difference in milk and manure production when lactating dairy cattle are fed different variety/phytase combinations. Results from this project could help dairy producers select the best product combination (corn variety and type of phytase additive) for increasing milk production and reducing manure load.

2000-03551 Integrated Unit Operations for a Sustainable Aquaculture Process

Brune, D.E.; Collier, J.A.; Schwedler, T.E.; Eversole, A.G; Hammig, M.
Clemson University; Department of Agricultural & Biological Engineering; Clemson SC 29634

Grant 2001-35209-10119; $170,000, 2 Years

In 1998, U.S. Aquaculture production passed 450 million kg/yr of finfish and shellfish production. Aquaculture is an ecologically efficient means of providing seafood for American consumers, reducing fishing pressure on wild fisheries and reducing dependence on imports. However, future growth of the aquaculture industry is limited by the finite supply of water and by pollutants from untreated fish farm effluents. As part of a previously funded USDA-NRI

project, Clemson University researchers have developed and successfully demonstrated an innovative new technology, the Partitioned Aquaculture System (PAS), capable of increasing fish production four-fold over that of conventional aquaculture, to in excess of 20,000 kg/yr of catfish production per hectare of water with an additional 5000 kg/yr of tilapia production while simultaneously reducing feed and energy inputs. This proposed two year project is intended to further develop the PAS technology, specifically through the development and addition of improved algal harvest, increased filter feeder biomass production, and biogas generation. These added processes will reduce or eliminate the PAS dependence on external energy inputs (electricity) and externally supplied high protein feeds, while producing 22,000 to 33,000 kg/ha of catfish and 10,000 to 20,000 kg/ha of tilapia. This research is intended to produce a technology that will increase fish production six fold over existing pond aquaculture while reducing the need for expensive feeds and electricity and, at the same time, recovering waste nitrogen and phosphorus which are a pollutant threat to surface and groundwater supplies.

2000-03536 NED: A Practical Decision Support System for Ecological Management of Forest

Twery, M.J., Rauscher, H.M.; Nute, D.E.; Porter, W.D.
USDA Forest Service; Aiken Forestry Laboratory; Burlington, VT 05402-0968
Grant 2001-35108-10113; $326,000; 3 Years

Recent events have increased the pressure on forest manages to make ecologically sustainable, socially acceptable, and economically feasible decisions. Managers are expected to predict short- and long-term efforts in implementing different alternatives. And yet the scope and complexity implicit in supporting decisions which directly effect ecosystems management is unprecedented. Although a large body of scientific knowledge exists on relations between forest structure and pattern and ecosystem attributes, this information is spotty, widely scattered in technical journals, and frequently difficult to interpret and apply. Furthermore, the incorporation of stakeholders' knowledge and goals, the adoption of "soft" science approach and the integration of social disciplines, theories, and measurement techniques is a significant challenge to many traditionally trained resource managers. Traditional forest management theory and tools have so far failed to effectively adapt to this new reality. One of today's greatest scientific challenges is the development of new theories and tools that describe the multiple ramifications of management decisions and that provide a practical, understandable decision process. Developing, evaluating, and adapting new decision processes and their supporting software tools is a critically important endeavor.

The objectives of this proposal are to develop and test (1) an operationally practical decision support analysis process and (2) the necessary decision support tools for conducting ecosystem management. The adoption and use of efficient and affordable decision processes and their supporting software would represent significant progress in operationalizing the ecosystem management paradigm. Forest managers and interested stakeholders can have (1) a transparent, clear, and understandable process, that (2) provides logical and concise results, where (3) choices are explicit and open to examination, and (4) limits on time, expertise, and money are expressly accommodated. The NED decision analysis process and software tools can provide research scientists with a vehicle to synthesize, integrate and deliver biological and socio-economic knowledge in an accessible, useable format. NED can provide managers with a powerful, yet understandable, decision support tool to help them cope with the biological and political complexity inherent in their job.

2000-03562 Enhancing the Viability of Local Agri-Food Systems

Jussaume, R.A.; Jarosz, L.A.
Washington State University; Department of Rural Sociology; Pullman, WA 99164-4006
Grant 2001-3520910174; $202,000; 2 Years

Our project seeks to enhance the viability of small farms by discovering the extent to which small farms are embedded in local agri-food systems, and identifying the constraints and opportunities these farms face in enhancing their viability. The research will begin with an historical analysis of the food systems in three counties in Washington State. Subsequently, GIS technology will be used to produce maps detailing land ownership change, land use change, and the locations of key suppliers, producers, workers, distributors and service and retail food outlets linked to food producers in each of the three study sites. Focus groups of suppliers, producers, workers, distributors and service and retail food outlets will be conducted to further our understanding of the meanings of these maps, and will also be used to develop a mail survey that defines stakeholders participation in local agri-food systems. We will also arrange interviews with key informants to deepen our understanding of issues emerging from the focus group interviews. Our results will be made available to citizens' organizations and interested public and educational institutions through the creation of a website, the development of college and university course materials on sustainable agriculture and agri-food systems, and through presentations to various audiences in publications and at conferences.